TITLE
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Resolving the X-ray Spectral Paradox: XMM-Newton Spectra of Faint Sources in the Lockman Hole

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Abstract. Using 100ks of XMM-Newton data on the Lockman Hole, we show how the X-ray background 'spectral paradox' is being resolved. We find the summed spectra of the Type I AGN, Type II AGN, and the unidentified objects. We conclude that the hard slope of the XRB is caused predominantly by latter sources, i.e. the Type II AGN and unidentified objects.

1. Introduction

The X-ray background has an effective energy spectral index of 0.4 between 2 and 20 keV, whereas AGNs have steeper spectral indices (0.8 for Type I). One of the major goals of the current generation of X-ray observatories has been to identify those source populations which are primarily responsible for the bulk of the overall energy density, which peaks at 30 kev. In particular, we aim to classify those sources contributing to the source counts in the range 2 - 10 kev, and to recognize those with the hardest spectra.

2. Observations and Results

The XMM-Newton observatory was pointed at the Lockman Hole in Apr./May 2000, resulting in a total of $\sim$100 ks. of useful data.

A total of $\sim$ 150 sources was detected, as reported in Hasinger et al. 2000 (A&A, **365**, L45). Of these sources, about 50 were previously detected with ROSAT, so that about 100 are new detections with XMM-Newton.

Summed x-ray spectra (Table 1) are shown in Fig. 1 for sources with redshifts from optical spectroscopy (Lehmann et al 2001 A&A **371**, 833), and for sources with no ROSAT counterpart (and hence no optical counterpart as yet). The summed X-ray spectra of type I AGN, type II AGN, and objects without optical identification are shown.

3. Conclusions

From a deep XMM-Newton observation of the Lockman Hole, and using optical identifications established following the deep ROSAT survey of the same area, we have found that:

Figure 1. Spectra Summed by AGN Type
top AGN Type I, *middle* AGN Type II, *bottom* unidentified sources, hard-selected

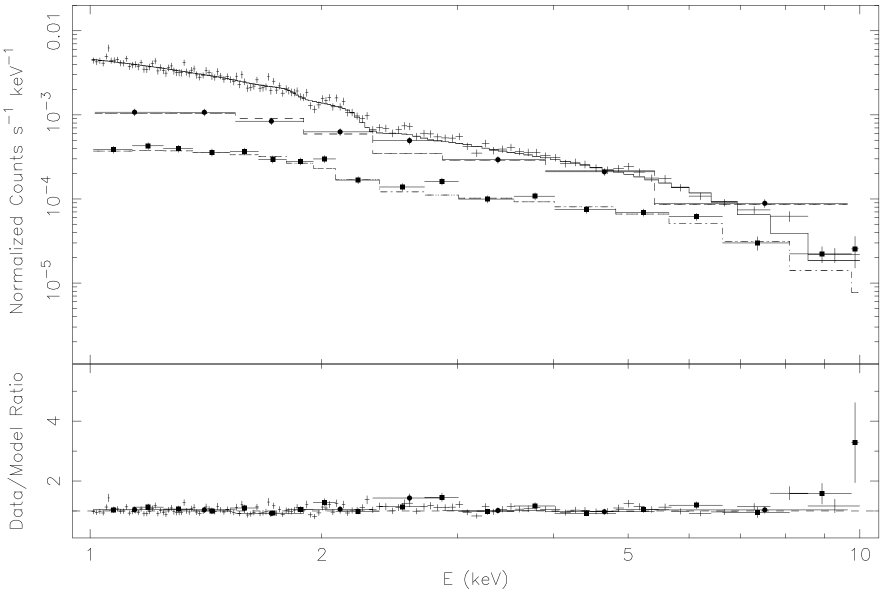

Table 1. X-ray Spectral Indices

Fit	N	Nh	Gamma	F(2-10)	Chisq/dof
		10^{21} cm^{-2}			
AGN I	42	0.5 (< 1.1)	1.87 (1.80-1.94)	2.32e-14	632/606
AGN I*	27	0.4 (< 1.0)	1.85 (1.78-1.92)	3.55e-14	600/562
AGN II	5	2.6 (< 5.4)	1.19 (0.93-1.45)	2.68e-15	71/71
No ROSAT ID	99	0.0 (< 1.4)	1.49 (1.39-1.68)	3.58e-15	711/635
No ROSAT ID*	40	1.8 (< 3.7)	1.11 (0.93-1.31)	7.06e-15	284/309

* = selected to have a > 90% confidence detection in the 5-8 keV bandpass. F(2-10) is the mean flux/galaxy in cgs units. All AGN II galaxies have significant detection in the hard band. N = number of galaxy spectra summed
AGN I = sources in Lehmann et al. with class = a-c
AGN II = sources in Lehmann et al. with class = d

(i) Type I AGN have an ave. spectral index of about 1.85 over 2 − 10 keV
(ii) Type II AGN have an average energy spectral index of about 1.2
(iii) sources with no optical spectra (thus far) have an energy spectral index of 1.5, or 1.1 for the hard-selected sources (5 - 8 kev)

Extrapolating to higher energies, it is evident that AGNs of Type II and (non-ROSAT) unidentified sources make up the bulk of the energy in the XRB.

Acknowledgments. These observations were made using the XMM-Newton X-ray observatory, built, launched and operated by the European Space Agency with NASA participation. These results rely heavily on the analysis performed and reported by Guenther Hasinger and colleagues (A&A 2000 **365**, L45).